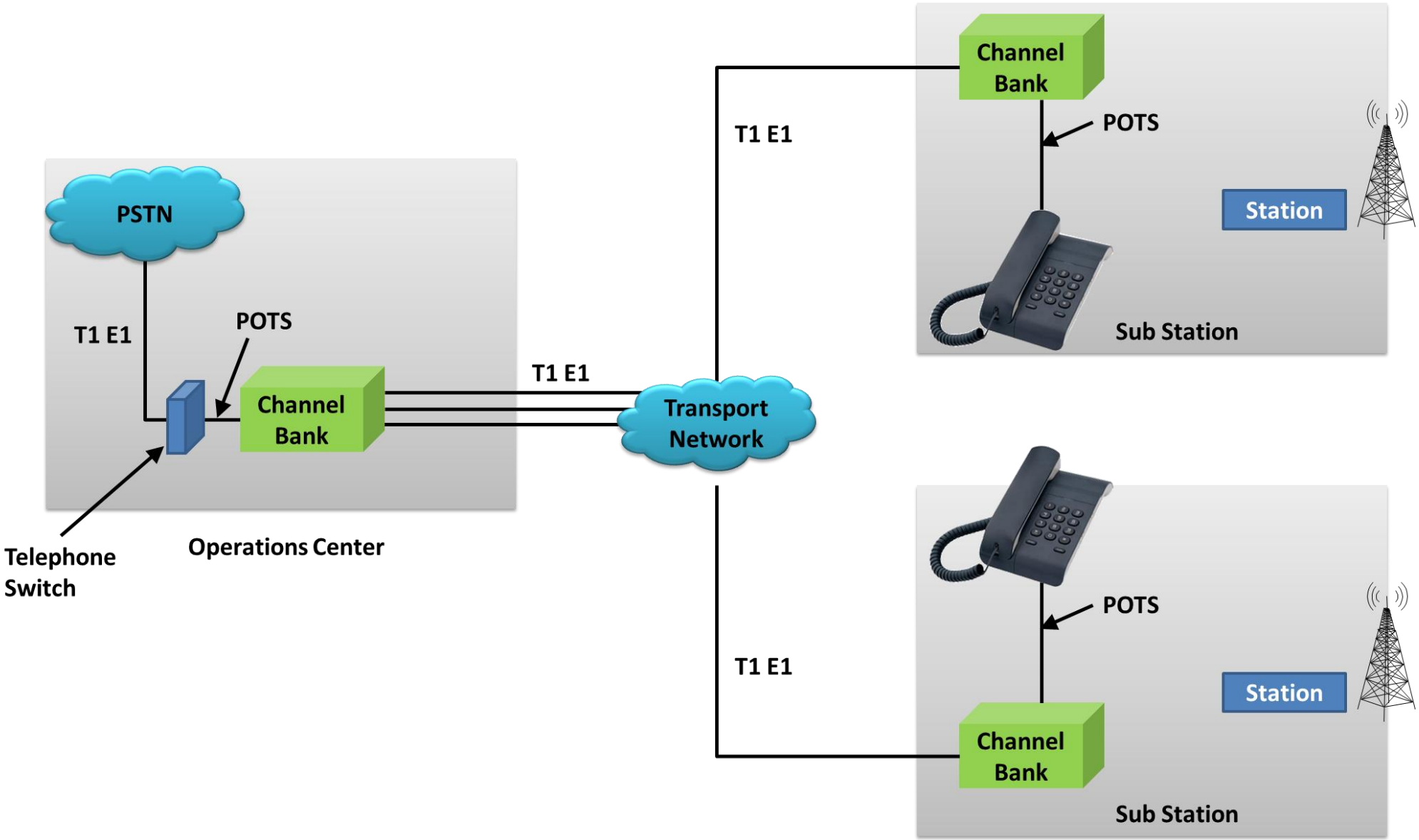
T1 E1 Overview

GL Communications Inc.
818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878
Phone: (301) 670-4784 Fax: (301) 670-9187 Email: info@gl.com
Website: https://www.gl.com

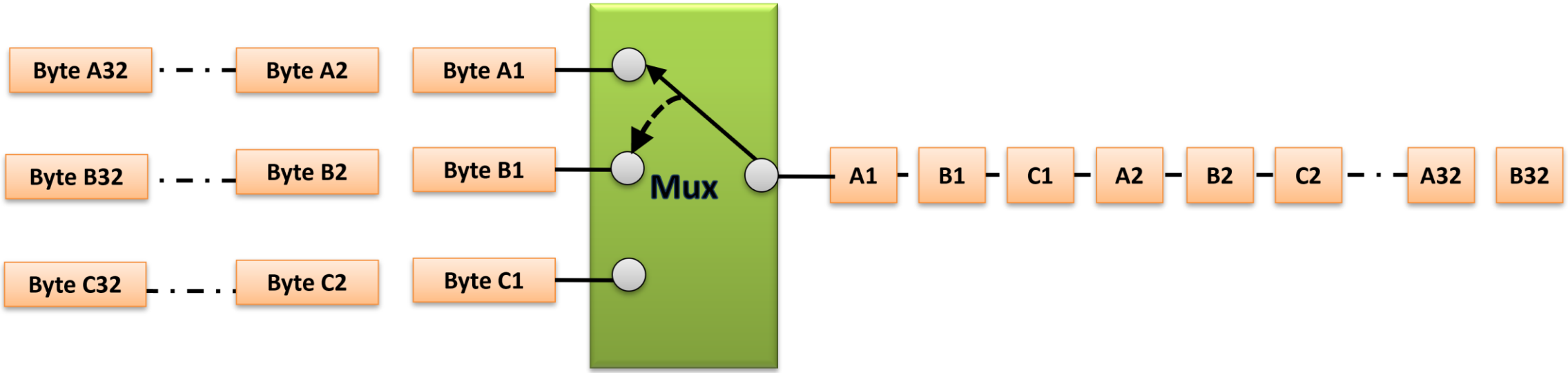
Introduction

- This presentation will explain -
  - TDM
  - Basics of T1 and E1
  - T1 and E1 Frames Structure
  - T1 and E1 Line Coding
  - T1 and E1 Alarms
  - T1 and E1 Signaling

T1 E1 Network



Time Division Multiplexing



TDM technology is used to multiplex several digital voice channels onto a single, higher speed line

- The time domain is divided into several recurrent timeslots of fixed length, one for each sub-channel
- One TDM frame consists of one timeslot per sub-channel

T1 E1 Overview

- T1 - developed by AT&T , is used in America, provides a 1.544 Mbps communication link
- E1 - is used in Europe, provides a 2.048 Mbps communications link
- Belong to the first two layers of the OSI –physical and data-link layers
- Uses time division multiplexing to “slice up” data and assign time slots for transmissions

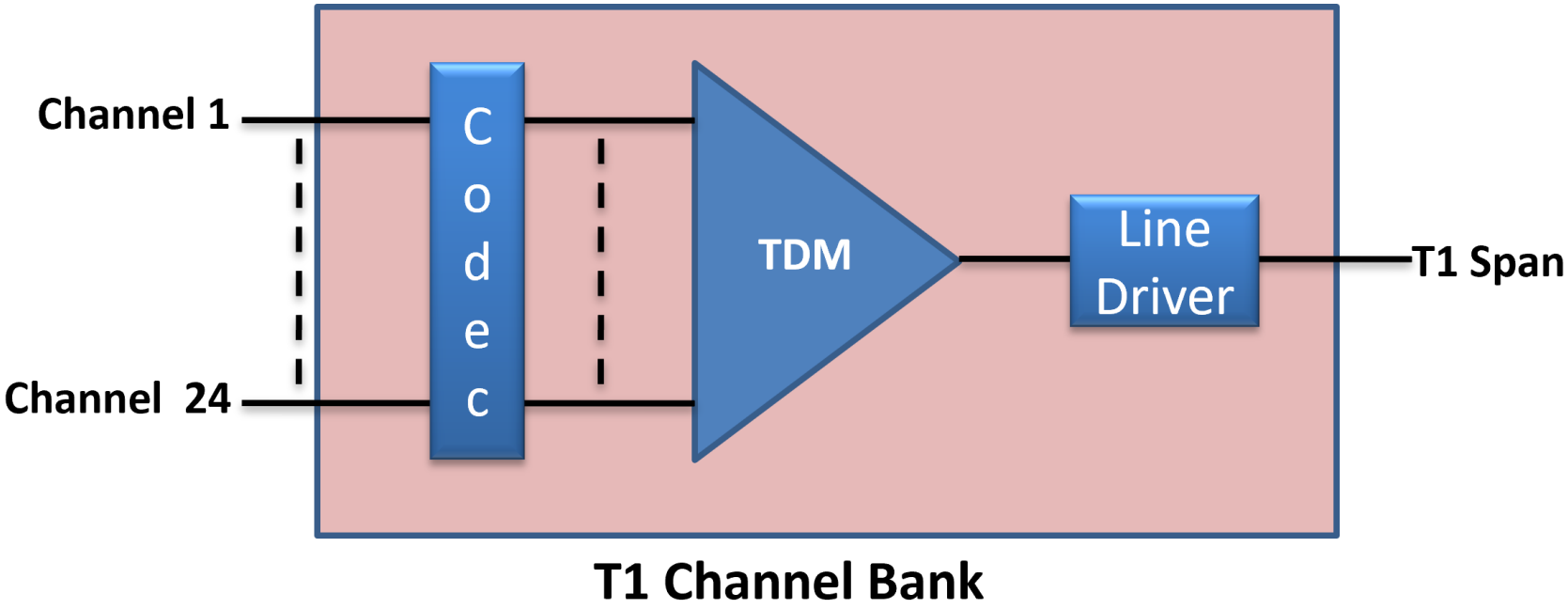
T1 E1 Advantages

- More efficient - multiple channels are multiplexed and transmitted over a common transmission path
- Economical when compared to the number of equivalent Analog lines that would be required
- Reliable - repeaters maintain the integrity of the digital signals over long distances
- High speed and high reliability digital data and voice transmission

T1 Carrier Basics

- Transmission of signals at the rate of 1.544 million bits per second (Mbps)
- T1 media types – twisted pair cable, coaxial cable, microwave radio, fiber optic cable, and satellite
- A T1 line is point-to-point. T1 lines may be used fractionally or at their full bandwidth
- T1 frame consists of 24 timeslots
- Related Specifications
  - AT&T Pub 62411 (D4, Line Characteristics)
  - AT&T Pub 54016 (ESF)
  - ANSI T1.403 (DS1 Metallic Interface)

T1 Channel Bank



- Channel bank is a simple multiplexing device used in T1 applications
- Channel Bank performs the following functions -
  - Pulse Code Modulation
  - Multiplexing

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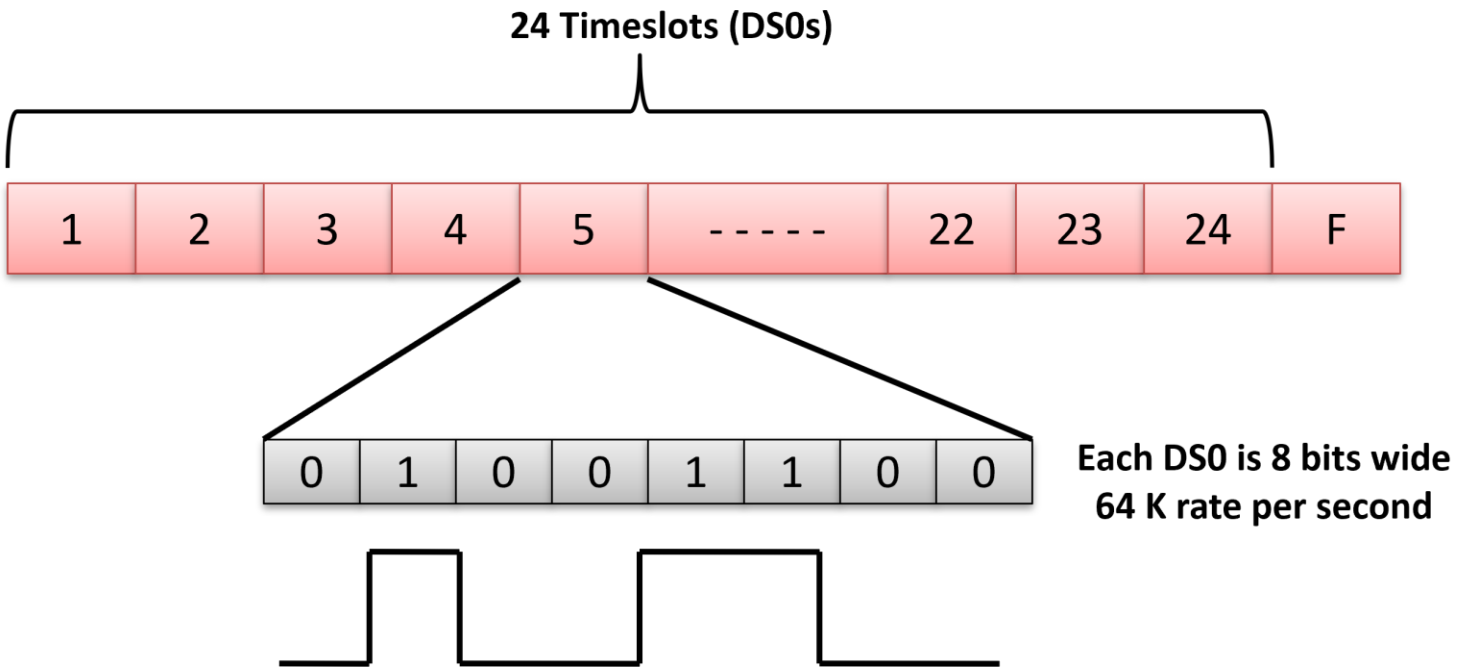
T1 Frame Types

- The T1 interface supports 4 different frame structures, dictated by the mode of operation:
  - Frame
  - Super Frame (SF)
  - Extended Super Frame (ESF)
  - Unframed

T1 Frame Structure



- T1 frame is constructed of 24 timeslots (each timeslots is of 8 bits) plus one framing bit added
- Total frame length is193 bits
- Each TS is regarded as a channel of 64 kbit/s bandwidth
- Framing bit creates a channel of 8kbit/s and is used for messages, synchronization, and alarms
- A frame is the basic building block for the SF and the ESF

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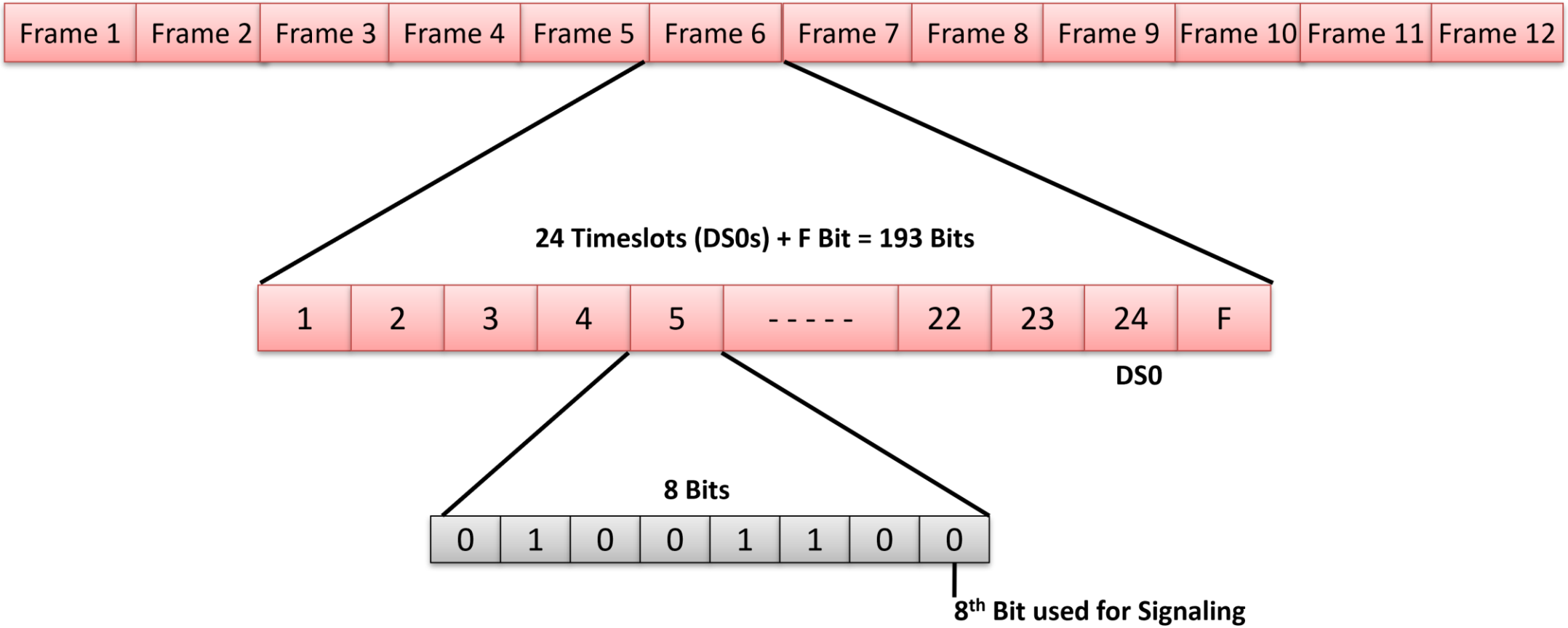
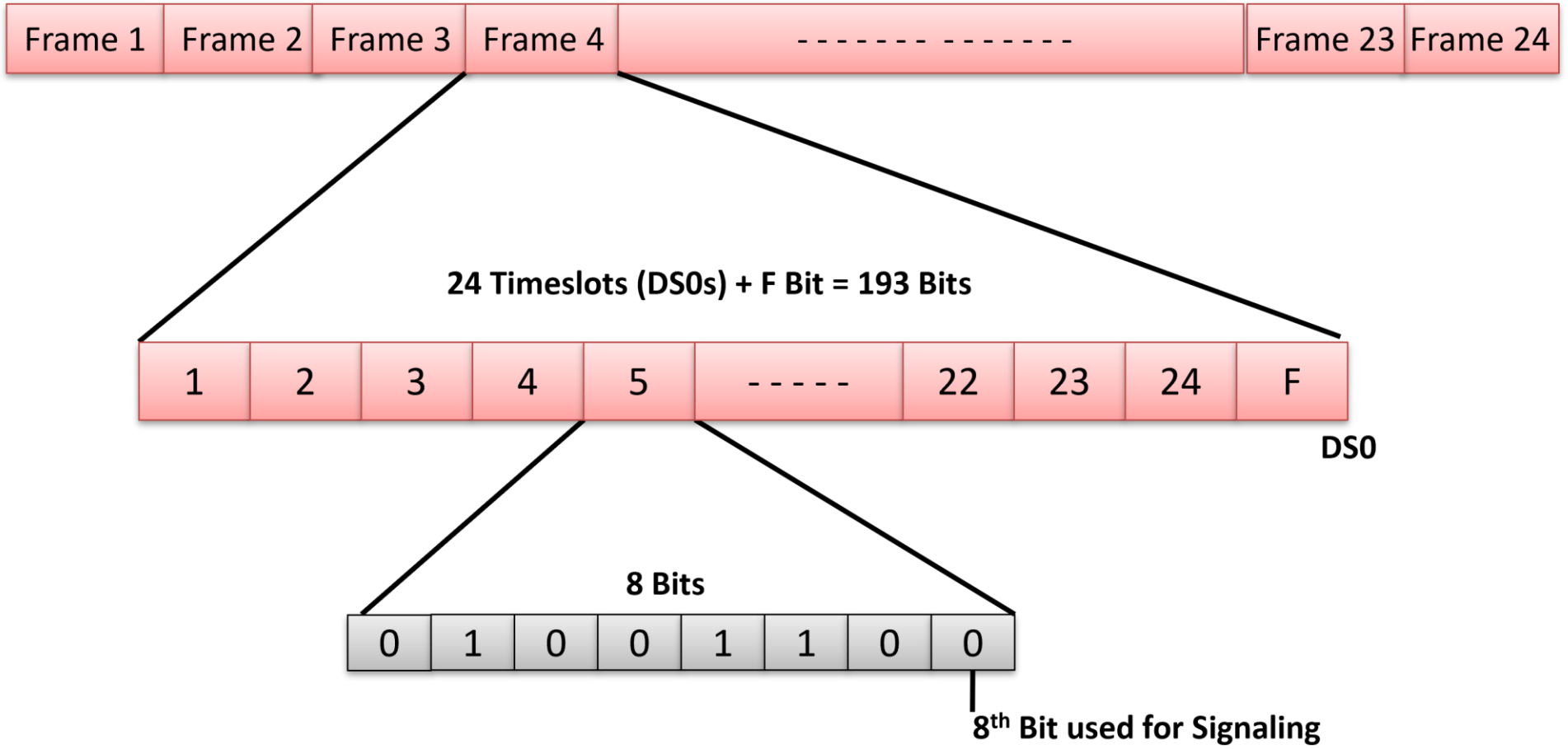
T1 Super Frame Structure



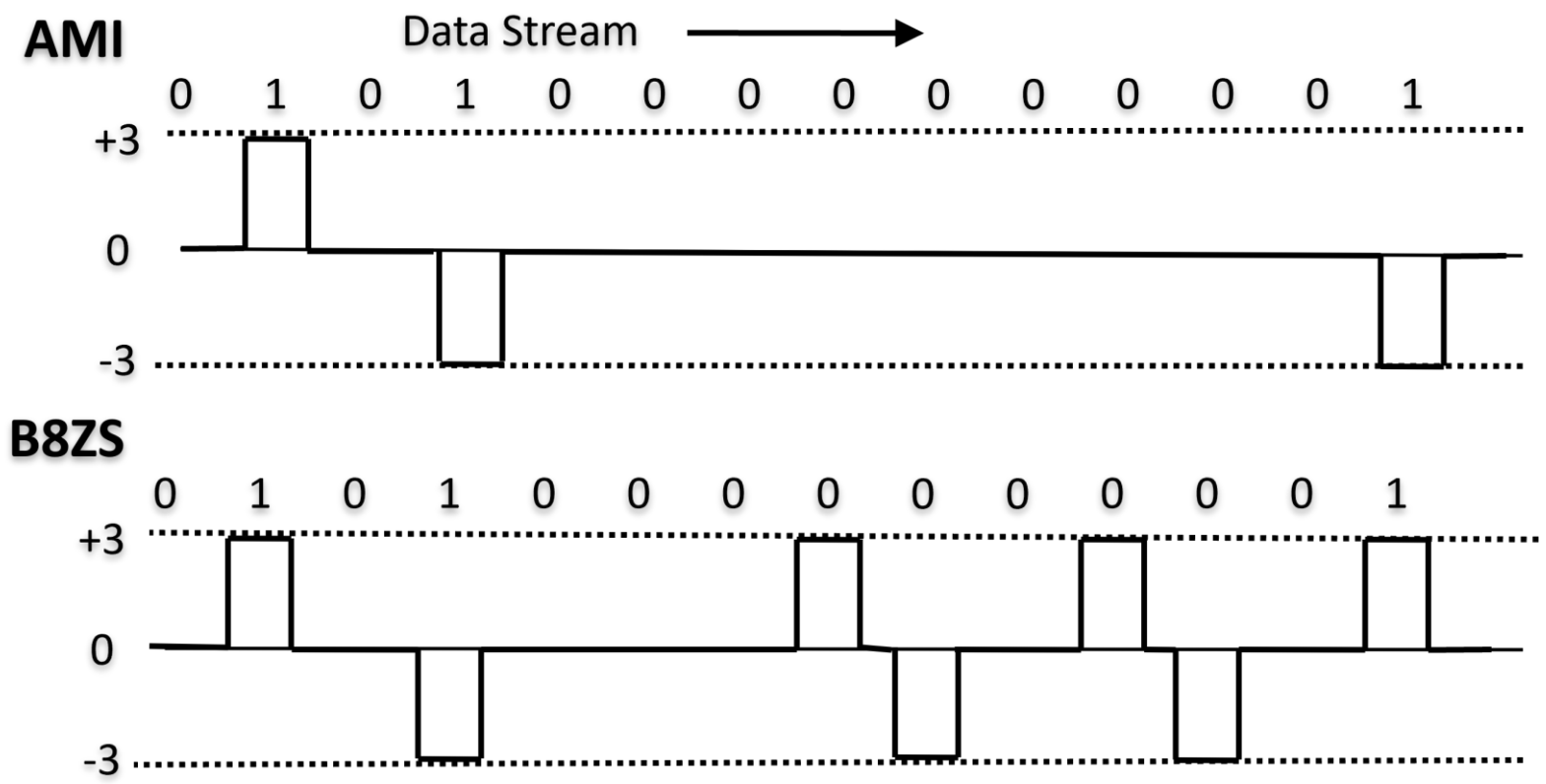
- Group of 12 Frames
- Used to align equipment for framing

T1 Extended Super Frame Structure



- Group of 24 Frames
- Used to align equipment for framing

T1 Line Encoding



- Standard formats of T1 signal -
  - Alternate Mark Inversion (AMI)
  - Binary Eight Zero Substitution (B8ZS)

Synchronization between Two Multiplexers
T1 Ones Density

- T1 line must contain frequent one's to maintain proper synchronization between two multiplexers
- Timing information is derived from the received data signal since there is no separate clock signal
- A T1 carrier cannot have more than 15 consecutive zero's and there must be approximately three one's in every 24 consecutive bits
- To maintain density, the following methods are employed –
  - Pulse Stuffing - Sets the eighth bit in every byte to a value of 1. Hence, only the first seven bits can be used for data, resulting in 56 kbps channels
  - Line Coding - Coding sequence is inserted to replace a long string of zeros

T1 Alarms

- Alarm signals have different color designations and are used to indicate serious problems on the link
- T1 alarms include –
  - AIS (Alarm Indication Signal) CFA - Also known as a "Keep Alive" or "Blue Alarm" signal. indicates the total absence of incoming signal
  - Red Alarm - indicates that the incoming signal has been corrupted for a number of seconds
  - Yellow Alarm –alerts the network that a failure has been detected
  - OOF (Out-Of-Frame) Condition - Occurs whenever Network or DTE equipment senses errors in the incoming framing pattern
  - LOS (Loss Of Signal) - declared when no pulses have been detected in a 175 +/- 75 pulse window (100-to-250-bit times)

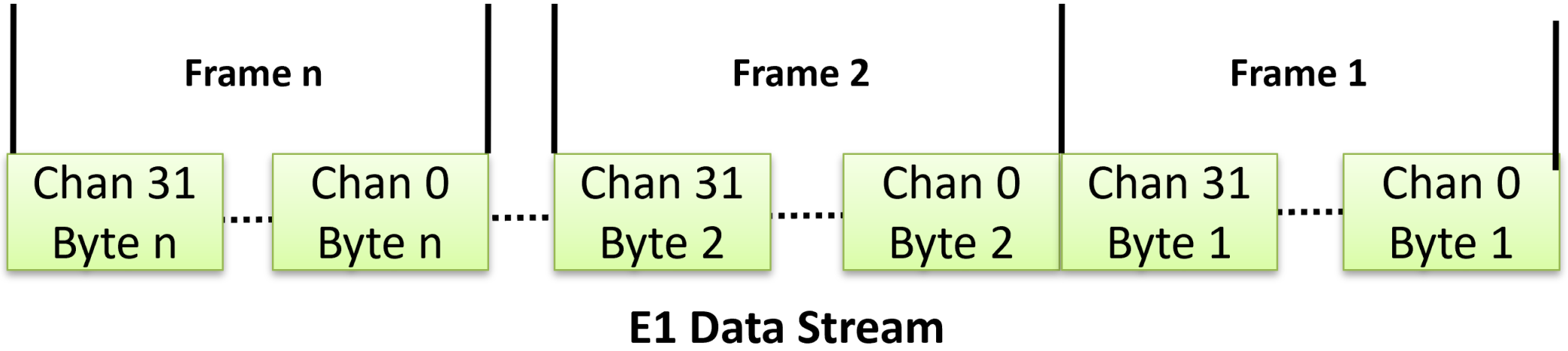
E1 Carrier Basics

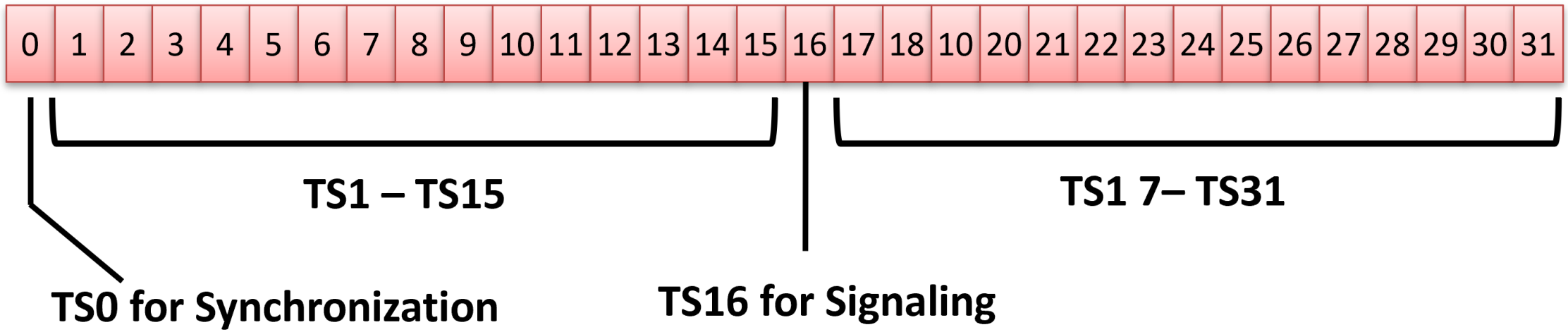
- E1 is a digital communication link that enables the transmission of voice, data, and video signals at the rate of 2.048 million bits per second (Mbps)
- Deployed primarily in Europe and Asia
- E1 frame consists of 32 timeslots
- E1 specifications defined in CCITT Recommendation G.704, although Recommendation G.732 supplements G.704

E1 Frame Types

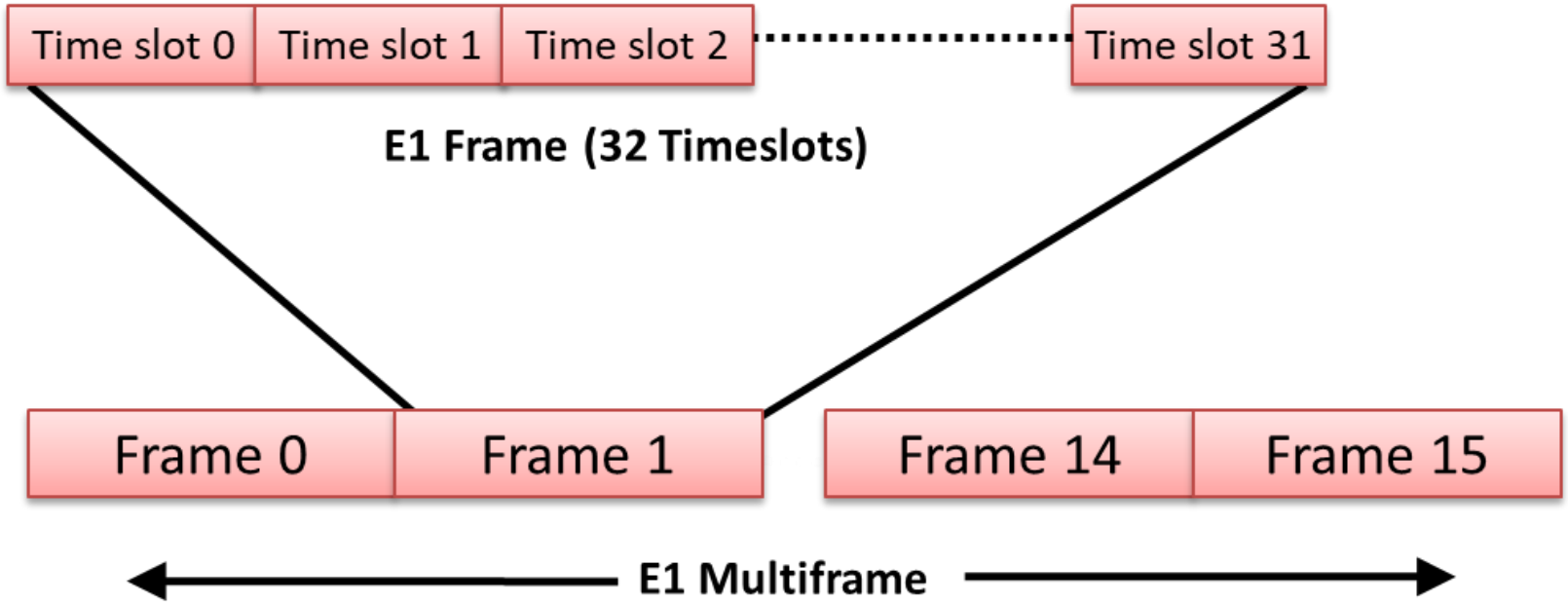
- E1 support various modes, and all use 2048 KKB/s:
  - Unframed (UNF) - stream of 2048 KKB/s with no channel association
  - Framed (FR) - all 32 slots are used for data, detection of boundaries is gained with TS0
  - Multi-Framed (MF) - TS0 is used for synchronization, all other channels are unaffected

E1 Frame Structure





E1 Multi-frame Structure

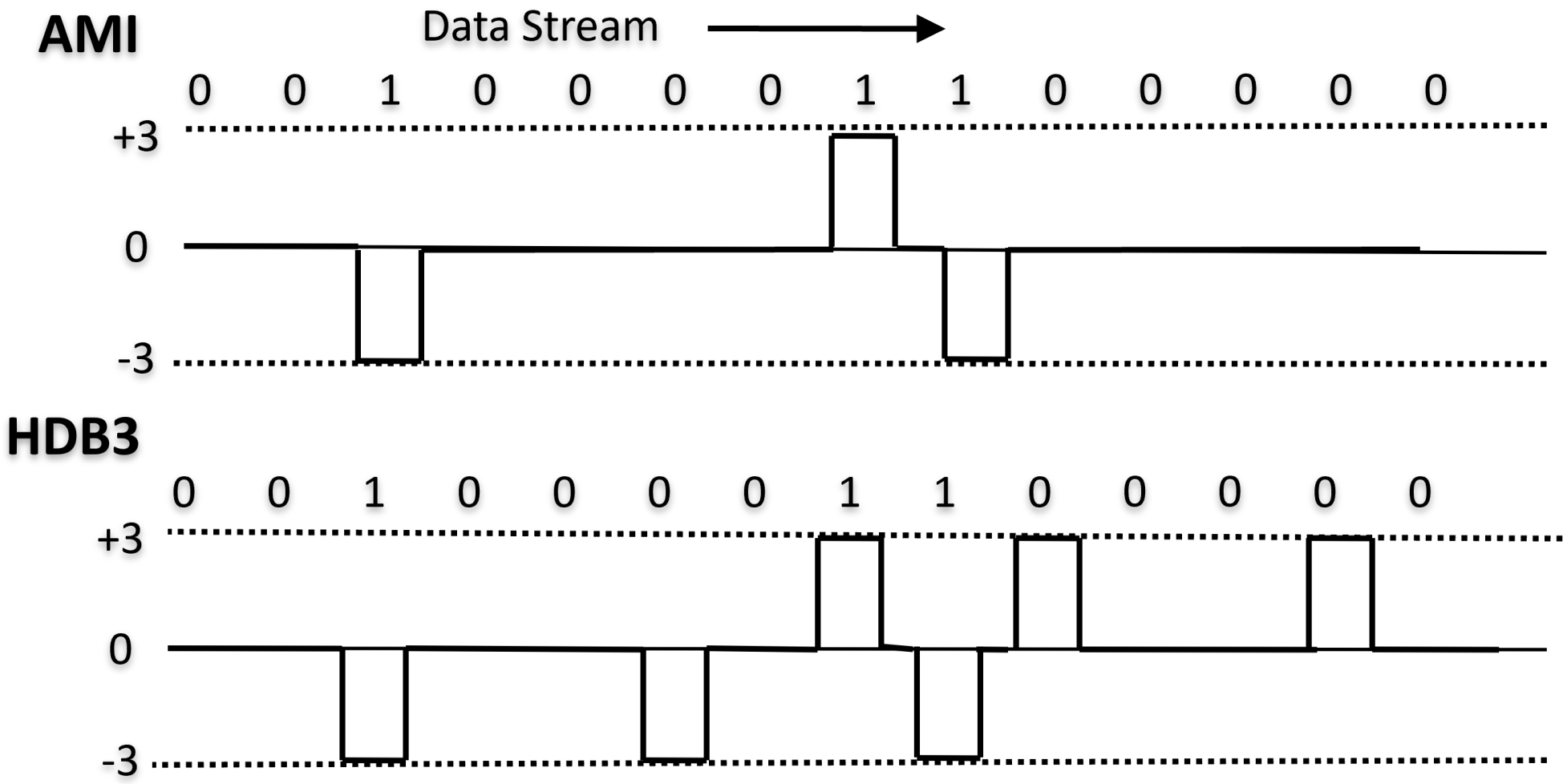


- The E1 multiframe consists of 16 consecutive E1 frames
- The extra features to multi-frame is the addition of a Cyclic Redundancy Check (CRC), and Channel Associated Signaling (CAS)

E1 Alarms

- Alarm signals have different color designations and are used to indicate serious problems on the link
- E1 alarms include –
  - Red Alarm - Generated by the device at the receiving end of an E1 line to report a loss of signal or frame alignment (synchronization) in the signal being received
  - Yellow Alarm – This alarm is transmitted on loss of signal (LOS), loss of frame alignment (LFA), or loss of multi-frame alignment (LFMA)

E1 Line Encoding



Synchronization between Two Multiplexers
E1 Ones Density

- E1 line contains frequent one’s to maintain proper synchronization between two multiplexers
- An E1 line is monitored for any group of four consecutive zeros
- Maintaining Ones Density employs the following methods –
  - Bipolar variations (BPV)
  - E1 lines employs HDB3 (high density bipolar 3) line encoding

E1 Transmission

- Data is sent over one signal pair and simultaneously received on another signal pair (full duplex transmission)
- Before the data is output to the E1 line, it must be conditioned by the line driver to meet the electrical characteristics of the E1 span (pulse width, pulse height, and pulse voltages)
- Line driver converts the unipolar signal output from the multiplexer into a bipolar signal (each successive digital 1 has the opposite polarity of the previous one)
- E1 transmission uses Bi-polar Return to Zeer (BRZ) framing format

T1 E1 Signaling

- T1 E1 line also conveys signaling information for each of the channels, in addition to carrying digital voice signals
- T1 Signaling includes –
  - Channel Associated Signaling (CAS) or Robbed Bit Signaling. This further includes
    - E&M Signaling
    - Loop Start Signaling
    - Ground Start Signaling
  - Common Channel Signaling (CCS) – This further includes –
    - Primary Rate ISDN
    - Signaling System 7
- E1 Signaling includes -
  - Basic ABCD Signaling
  - CCS (Common Channel)
  - Clear Channel

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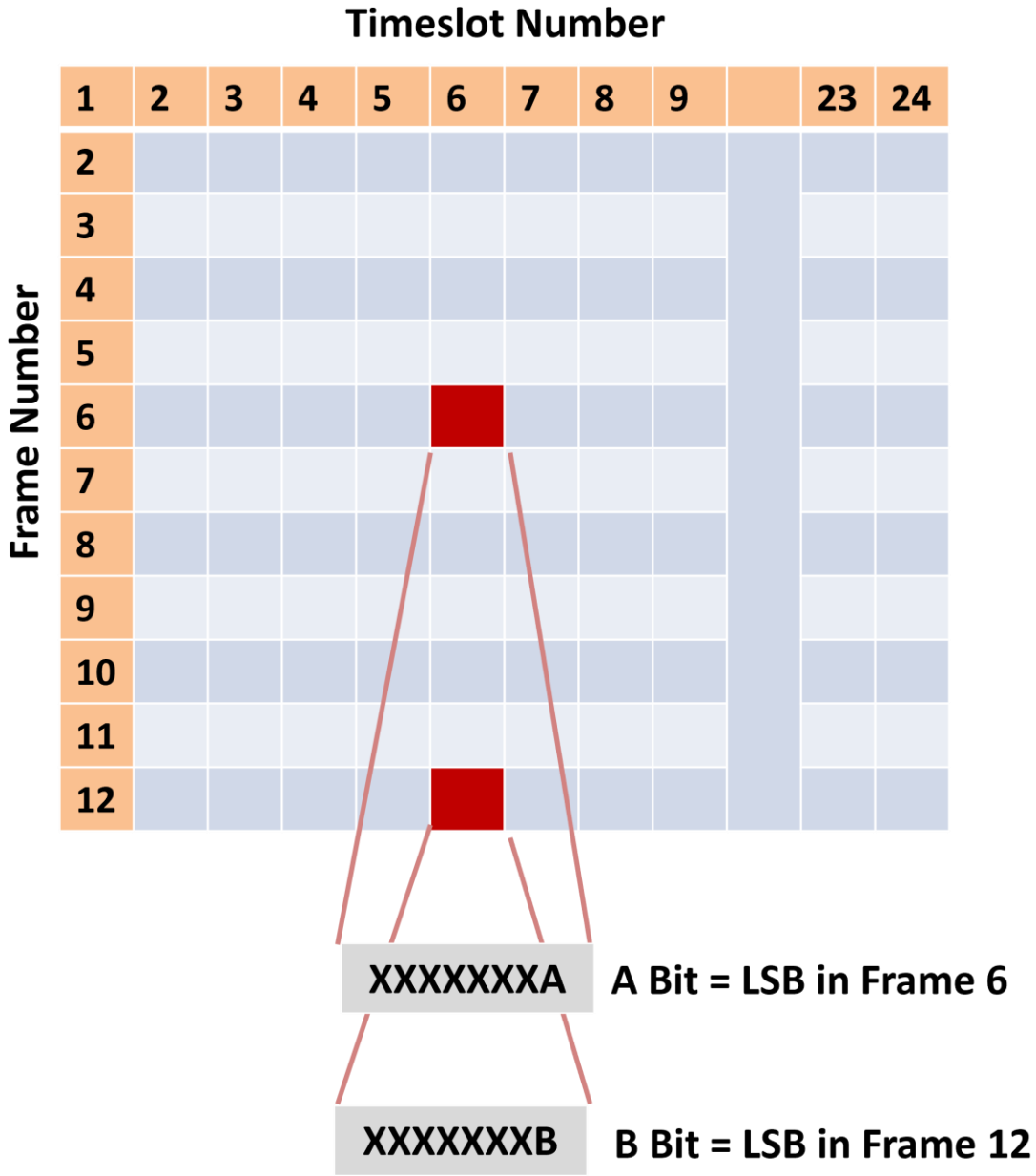
Channel Associated Signaling in T1



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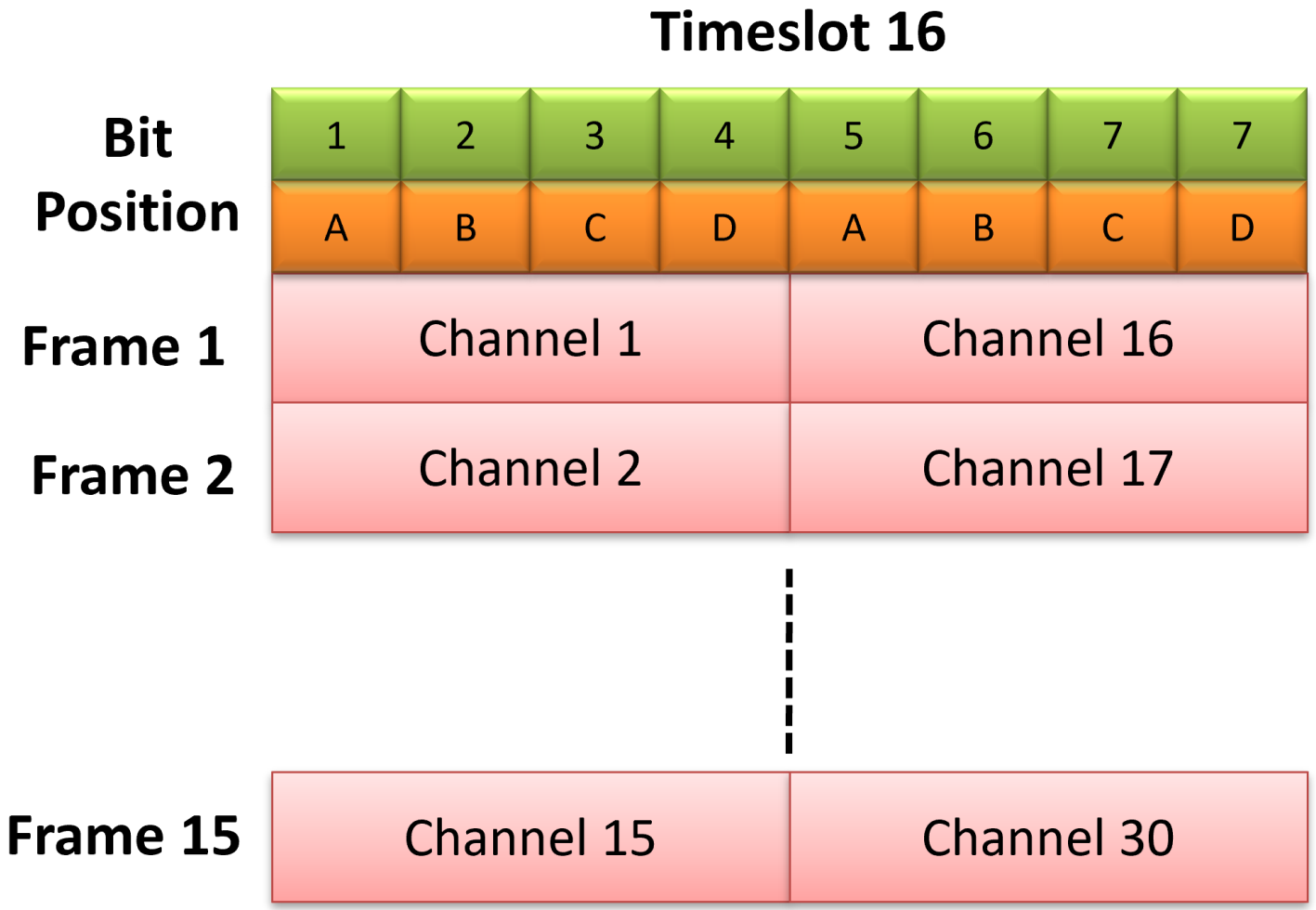
Channel Associated Signaling on E1
Basic ABCD Signaling



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Common Channel Signaling

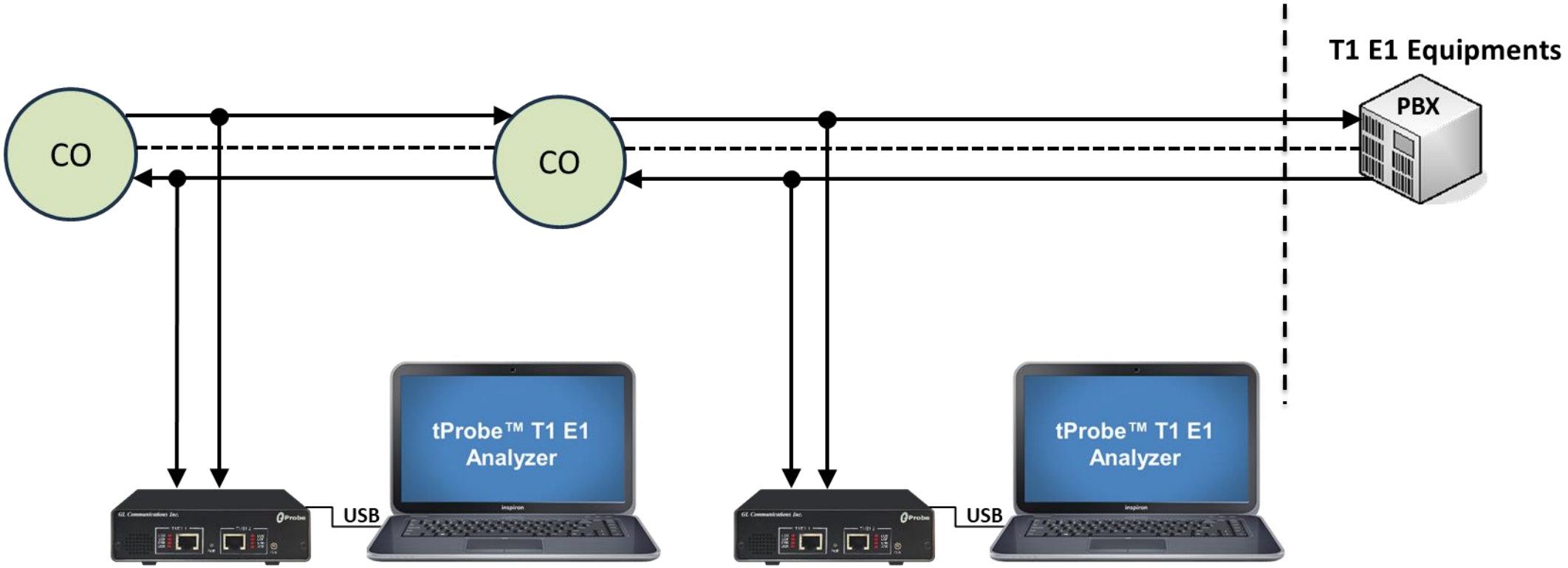
- Common channel signaling (CCS) is a method in which a separate channel is used to carry the signaling information for a group of other channels
- Common channel can be in band out-of-band
- In E1, timeslot 16 is used to carry signaling information
- In T1, timeslot 23 is used to carry signaling information
- The most common CCS signaling methods in use today are ISDN and SS7

Link Types and Bandwidth

Line Type	Signal Standard	Bit Rate Capacity
56	DS0	56 kbps
64	DS0	64 kbps
T1	DS1	1.544 Mbps
E1	___	2.048 Mbps
E3	___	34.064 Mbps
T3	DS3	44.736 Mbps

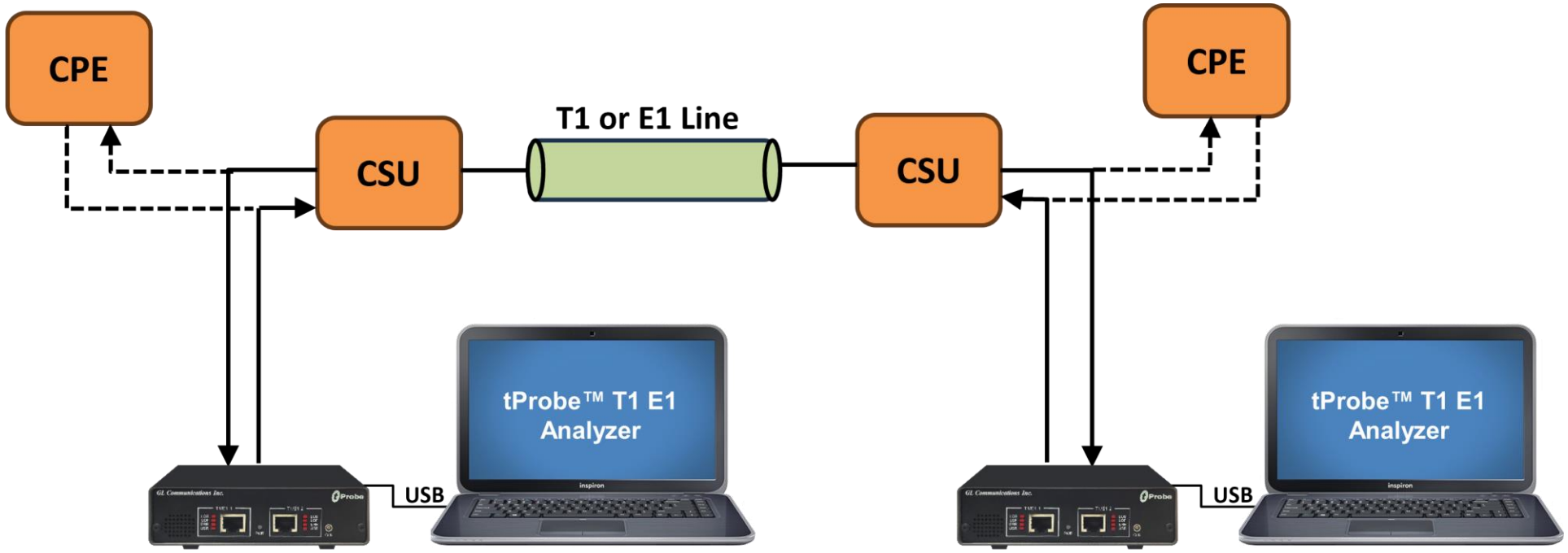
GL's T1 E1 Analyzer

Non-Intrusive Monitoring



GL's T1 E1 Analyzer (Contd.)

Intrusive Monitoring

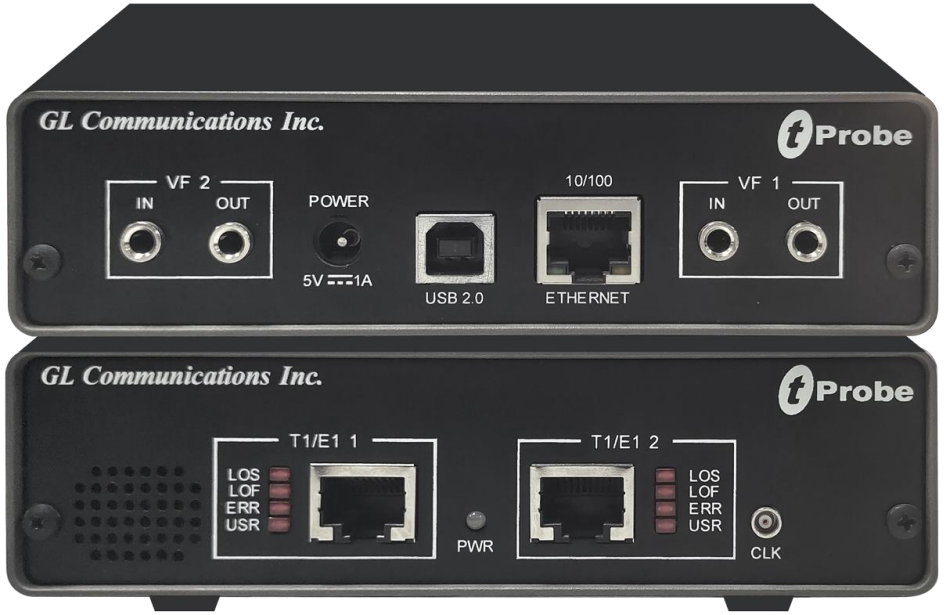


CPE = Customer Premise Equipment
CSU = Channel Service Unit

T1 E1 Analysis – Platforms

Back Panel

Front Panel



Portable T1 E1 tProbe™ Unit

Dual T1 E1 PCI Express Card

- USB connectivity provides a plug-and-play interface to any PC allowing portability and convenience
- Dual T1 E1 PCI Express Cards is an enhanced PC-Based T1 and E1 solution that is capable of both T1 and E1 interfacing in the same hardware

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Basic and Optional Applications

- **Monitoring Applications –**
  - Monitor T1 E1 Line, Byte Values and Binary Byte Values, Signaling bits, Power Level, DC Offset, and Frequency, Multiframes, and Real-time Multiframes, Oscilloscope, and more
- **Intrusive Applications**
  - Bit Error Rate Test, Enhanced Bit Error Rate, Transmit Tone, Transmit Gaussian Noise, Transmit Multiframe, Transmit Signaling Bits , and more
- **Special Applications**
  - Protocol analysis and emulation, Signaling transitions, Call capture application, record/playback applications, Echo cancellation testing/compliance, Mux / De-mux software, Windows Client-Server, and more

Thank you